Quarterly EOS Contract Report - Report #69

Period: July 1 - September 30, 1997

Remote Sensing Group (RSG), Optical Sciences Center at the University of Arizona

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Report compiled by: K. Thome

Summary:
Activities during the past quarter included attendance at the San Diego SPIE meeting where five papers from the group were presented and S. Biggar chaired a session on EOS calibration. Activities during the past quarter included attendance at the San Diego SPIE meeting where five papers from the group were presented and S. Biggar chaired a session on EOS calibration. P. Slater attended the IGARSS'97 meeting in Singapore where he co-chaired, with V. Salomonson, a session titled "High Resolution Sensors". He gave a talk titled "Solar-Radiation-Based Calibration" to CSIRO and University of Curtin members in Perth, Western Australia. He chaired a session on "Sensor Calibration" at the EUROPTO meeting in London. Preliminary results from the June Lunar Lake campaign were sent by email to EOS Calibration Scientist, Jim Butler, less than two weeks after the completion of the campaign. Evaluation of the diffuse-to-global instrument continued as did work on the BRDF camera. Cross-calibration software was upgraded to operate with IDL5.0 and aerosol inversion software was ported to our Sun-based network. Results of the blacklab measurements of the reference panels from the Lunar Lake campaign were sent to the participants and a second set of measurements of a NIST reference sample were made and processed. Data were collected to examine the accuracy of three methods for calibrating the VNIR CCR.

Task Progress:
S. Biggar, B. Crowther, J. LaMarr, R. Parada, P. Spyak, and E. Zalewski attended the SPIE conference in San Diego the week of July 28. Biggar chaired a session of the conference related to EOS calibration. Crowther presented a paper on the cosine collector of the diffuse-to-global meter, and LaMarr presented his work on the autotracking solar radiometer. Because M. Sicard was unable to attend, Spyak described the work he and Sicard did with the Cimel TIR radiometer. Spyak also presented a paper on modeling laboratory transmittance in the SWIR. Parada gave a talk on calibrating the MMR in the laboratory and field.

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and 12 where MCST described their work related to the TIR bands of MODIS. N. Che, H. Montgomery and B. Guenther of MCST traveled to Tucson to meet with Biggar, Thome, and Zalewski to describe results of the characterization of the SRCA of MODIS. B. Schowengerdt, PI of a recently selected MTPE Validation proposal, also attended the briefing. Thome met in Pasadena with B. Eng on September 18 to discuss work on the code development of the atmospheric correction of ASTER. Thome also met with the MISR Validation Team on September 19 to discuss the results of the Lunar Lake campaign.

Biggar modified the original SWIR CCR code to add error checking and forced configuration of the amplifier. He tested software written to run our lamp sources automatically and modified our software to process blacklab panel measurements. Biggar collected data with the VNIR CCR viewing a Spectralon panel illuminated by a NIST primary source. A similar setup was used by Zalewski to calibrate the SWIR CCR and by J. LaMarr for an Exotech calibration. The SWIR measurements also included complementary data from the ASD. The Exotech calibration used code modified by Biggar to operate with our Sun network. Biggar plans to check the results of the radiance calibration of the VNIR CCR to those of a solar-radiation-based calibration.

Biggar calibrated the VNIR CCR in irradiance mode as well using an FEL lamp and, at the same time, made measurements to evaluate the inverse-square law assumption applied to FEL lamps for adjusting irradiance for distance. This was done for three lamps, each at 2 wavelengths. Biggar found that a modified inverse-square law is required to accurately account for the distances different than the specified 50 cm. He will present some of these results as part of a paper he is presenting at the NewRAD '97 meeting.

Using software developed by Biggar, J. McCalmont reduced the blacklab data for all of the panel measurements taken prior to the recent Lunar Lake field campaign and the results were sent to the campaign's participants. At Biggar's direction, Z. Rouf made extensive measurements of our Algoflon samples. He collected several sets of data from -85 degree to +85 degree at 5-degree intervals to check the uniformity of the sample. These measurements were done for all of the bands in the VNIR with the radiometer fixed and the panel rotating and also for the panel fixed with the radiometer rotating. Rouf collected several data sets at 1-degree intervals at a few selected wavelengths. The entire procedure was repeated with the Algoflon sample rotated 90 degrees clockwise from its normal orientation. Finally Rouf measured the directional reflectance of our two field Spectralon panels and of the NIST panel. The NIST panel measurements were made with normal orientation and with a 90-degree, clockwise rotation. Biggar and Burkhart developed shims for the NIST panel measurements to ensure that it was properly aligned. Biggar processed the data from these measurements as well as those of the BRDF round-robin measurements. Biggar shipped the panel back to NIST.

LaMarr and Rouf set up the Optronic OL750 monochromatic. LaMarr trained M. Mienko and Rouf on the operation of the monochromator and the two started working with the monochromator to measure the transmittance of filters from our field radiometers. Biggar and Rouf began developing

software to operate the Optronic monochromator in conjunction with a linear translation stage using a GPIB interface. Rouf established the GPIB connection for the Unidex 100 along with the stages with the host computer of the OL750. These stages will be used to change and hold the filters for the monochromator for transmittance measurement. E. Nelson and C. Burkhart made initial plans for incorporating the linear stage as part of the OL750. Biggar and Rouf began characterizing the interference filters from H. Kieffer's radiometer that is being used to calibrate the moon as a radiance source for MTPE sensors. Rouf measured the 940-nm filter using the silicon and germanium detectors. Biggar faxed the results to Kieffer. B Kindel of the University of Colorado, and part of A. Goetz's group, brought their ASD-FR on September 22 and 23 for calibration using our 40-inch SIS (radiance mode) and a NIST-primary FEL standard of spectral irradiance for calibration of their diffuser/ASD combination. Biggar is currently processing the data from this experiment.

K. Scott continued work on the cross-calibration software. She modified the existing software to make it compatible with Silicon Graphics workstations and to upgrade the software to IDL 5.0. These changes will make the software more robust and portable, as well as eliminate some of the minor problems seen on the Sun workstations. She also removed commands that have become obsolete and continued development of software used to identify areas in a test image based on areas selected by the user from a reference image. Software to be developed will allow the user to define the minimum and maximum digital counts desired in the test image and the misregistration error around each test-image pixel so that an average reference pixel digital count value can be obtained with an associated error. A widget will be developed to allow the user to select the test pixels to use for calibration. Scott began work on code to quantitatively assess the uncertainties in the cross-calibration work.

LaMarr, assisted by M. Zaheedul and J. Smith collected Langley plot data on the mornings of July 1 and 2 with the manual solar radiometer and the autotracking radiometer. LaMarr and Thome reduced these data for both instruments. The two also used the spectral-filter transmittances for the autotracker's filters along with MODTRAN3 output to simulate band-averaged transmittances for a variety of solar angles and atmospheric conditions. All of the above data were used as part of a paper presented by LaMarr at the SPIE conference mentioned above. LaMarr and Zaheedul tested the I/O board from the autotracker and determined that the board works and the cause of problems with the board are due to interrupt problems with the computer. Zaheedul developed software to move the Autotracker as desired and began work on software to track the sun continuously. He will begin work to incorporate the lead-sulfide detectors as well as automating the filter wheels.

LaMarr and Thome processed the TM and SPOT data from the May Jornada and White Sands campaigns. LaMarr developed software for our UNIX-based system to determine the Junge parameter for the aerosol size distribution and columnar ozone from solar radiometer data. The code was developed using ANSI C so it can be compiled under any operating system. LaMarr also investigated the possibility of rewriting some of the algorithm using mathematical inversion techniques. LaMarr began work on the AVIRIS

data from the Lunar Lake campaign and he histogrammed TM band 5 data to determine probable radiance values expected for the SWIR band that will be on the SPOT-5 HRV.

P. Nandy determined the blocking-filter requirements for the operation of the BRF camera in the field with the aperture fully open (F/2.8). This aperture is necessary to eliminate spot-formation on the image plane as a result of the nearly-telecentric optical path of the system. Nandy relied on data collected with the 40" spherical integrating source to determine the requirements of the filter to equalize band-to-band responsivity. He also tested the system outside with a barium sulfate panel to determine the band-to-band response signals under field conditions. Nandy determined that a 2-mm, NG9 filter would fulfill most of the system requirements and Nandy ordered and received an image-quality filter from Custom Scientific. Nandy tested the magnesium-fluoride and uncoated BG-34 filters and the new NG-9 in the Optronic monochromator to determine their spectral transmittances. Use of the two BG-34s also allowed measurement of the effectiveness of the anti-reflection coating. Surface figure and roughness were calculated for all three filters using a WYKO interferometer setup. Nandy installed the filters and tested the system outside. All exposures were close to predicted, producing adequate data values with a two second exposure.

Nandy began to evaluate the angular mapping of the BRF camera by mounting the camera head over a uniform grid of squares and taking multiple images at various elevations to isolate focal plane positional offsets. He conducted focus tests at full-open aperture (F/2.8) to determine the best focus position for the camera lens. Nandy also designed and implemented graphical interface routines for the BRF data-processing programs. The T6400 BRF camera computer suffered a hard-disk failure and was repaired. Nandy and Burkhart discussed methods to mount the camera for calibration with the 40-inch SIS and the creation of a repeatable alignment bracket for the camera head/housing. Biggar, Burkhart, and Nandy developed a method to attach the BRF camera to a linear actuator stage to translate the system across the aperture of the 40-inch SIS and Burkhart machined the assembly. Biggar and Nandy also investigated methods to rotate the camera head while viewing the SIS. Nandy looked into techniques to decouple the pixel-to-pixel variability of the CCD-array from the SIS non-uniformity using the linear and rotational translations.

J. Smith worked on the diffuse-to-global-meter data from the Lunar Lake campaign. She reviewed B. Crowther's dissertation and other related papers to understand the theory behind the instrument. Data from several bands were processed using the Langley method to determine spectral optical depths and evaluate the performance of the system. Smith also determined diffuse/global (D/G) ratios from the data and used these results to interpolate the D/G ratio to an airmass of 1 to be used in the irradiance-based calibration. Smith developed several shell scripts to handle the main "file housekeeping" and Excel spreadsheets to produce plots of the results. The methods used in this preliminary processing were used to develop the main IDL program to process the raw diffuse to global data. In this code, the user can choose from predefined site locations, or enter longitude and latitude directly. The diffuse count is interpolated to that of the global measurement's time to correct for

the 45 second difference between the two measurements. Smith wrote a module that allows the user to quickly view each scan, both diffuse and global, for a data collection period. She also wrote an ephemeris module based on the calculations from Duffet-Smith to calculate the airmass and solar zenith angle. Smith added a correction for temperature variation of the Licor Spectrometer and Langley plots and instantaneous optical depth can be plotted for a selected wavelength. Smith will add a correction for the sphere response and three dimensional data visualization and predefined band group processing to coincide with specific satellites. While testing the diffuse-to-global instrument in preparation for our next field trip, Smith found that the azimuth stage was unable to smoothly rotate the altitude assembly and she determined that the stage is not operating to specification. Smith will contact the manufacturer to remedy this situation.

W. Barber began work developing a new yoke or harness for field measurements with ASD FR. Barber and Burkhart designed a boom and fixture containing the mount for the optics, a laser targeting system, and a clinometer. The laser targeting system will help align the ASD on the reference panel. The clinometer helps the operator maintain the same view angle as that of the satellite at over pass. Barber and R. Kingston began fitting the Exotech/MMR yokes with a similar laser targeting system and simplifying the data collection with these yokes. Barber is also developing new stands for the yokes to make it easier for one person to use the yokes. Biggar and Nandy sent the ASD-FR for maintenance and upgrade. Nandy wrote software to allow ASD data from the JPL-MISR group from the Lunar Lake campaign to be processed by our software.

Burkhart completed designs of modifications to the field-reference stand. The modifications include using tripod legs for the stand and changing the location of the legs. Burkhart completed a second panel stand based on these modifications for our other Spectralon panel. The parts for this second stand were sent out to be anodized. Nelson constructed a transimpedance amplifier and packaged and mounted it to the back of the line-of-sight radiometer. He designed a post amplifier for the line-of-sight radiometer using batteries installed in the post amplifier housing. Nelson began establishing standard connectors for each voltage level of our various power sources and replaced slip on power connectors with solder joints. He also began developing battery chargers with these standard connectors.

Thome worked with C. Leff and A. Murray of JPL to begin generating the Version 2 LUT for ASTER atmospheric correction. Thome also processed the Lunar Lake data from 1800 UTC on June 24 to predict radiances at the top of the atmosphere and sent the results to the other five groups. All of the groups submitted their predictions for top-of-the-atmosphere radiance to Thome who then compiled a report and submitted this to EOS calibration scientist, Jim Butler on July 11. Thome continued processing the other Lunar Lake data. He also process data from the Jornada campaign and submitted the results to F. Rahman of the Soil and Water Sciences Department.

Barber and Biggar upgraded the office PCs to operate with Windows NT. They tested the electronic's lab HP and found it needed a new

motherboard, which was installed by HP. Biggar and Kingston replaced a
failed tape drive on the office HP. Barber continued to maintain and
administer the Windows NT 4.0 portion of our network to allow
administrative and budget work to be done by multiple people. Biggar and
Kingston set up a new Sun Workstation. Biggar also configured a
a notebook computer.